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Project Report
PCA-IRT-1

Preliminary Design Review: PCA Integrated Radar-Tracker Application

J.M. Lebak

9 April 2002
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Lincoln Laboratory
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
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Group 102

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ABSTRACT

The DARPA Polymorphous Computing Architecture (PCA) program is building advanced computer architectures that can reorganize their computation and communication structure to achieve better overall application performance. As part of the PCA program, MIT Lincoln Laboratory has been requested to provide examples of defense-oriented applications that will challenge the candidate architectures.

This report presents a high-level description of an example application involving a ground moving target indicator (GMTI) radar application and a feature-aided tracker application that work together.

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1. INTRODUCTION

The DARPA Polymorphous Computing Architecture (PCA) program is building advanced computer architectures that can reorganize their computation and communication structure to achieve better overall application performance. This reorganization is known as *morphing*. As part of the PCA program, Lincoln Laboratory has been requested to provide examples of defense-oriented applications that will challenge the candidate architectures. This report presents a ground moving target indicator (GMTI) radar application: this application was chosen because of its use of standard signal processing functions and linear algebra operations. We have also identified feature-aided tracking (FAT [2]) as a good application to present to the community because of its high performance requirements, its use of database operations, and its emphasis on thread-based as opposed to stream-based operations.

Our goal is to provide to the community a single Matlab program that integrates a moving target indicator (MTI) radar and a tracker. This will allow the teams building hardware to verify their application code and to have an "executable specification" for testing purposes. This report describes the high-level operation of the integrated radar-tracker in greater detail. Other documents ([1],[3]) describe the operation of the components of this application.

1.1 GENERAL DESCRIPTION

The two major components of the integrated radar-tracker are GMTI processing and feature-aided tracking. A block diagram of the components, indicating the data that flows between them, is shown in Figure 1.

Note that the GMTI system produces two types of data, GMTI output data (labelled "1" in Figure 1) and high range resolution (HRR) profiles (labelled "3" in Figure 1). The primary function of GMTI processing is to process wideband sensor data to detect moving targets on the ground. Detections are performed and object centers are identified (this is referred to as detection "clustering"). An HRR profile is a set of wideband data extracted from around the defined center of an object. The characteristics of the HRR profile can then be used by the FAT to distinguish among different targets and perform target classification.

GMTI processing operates, essentially, on "snapshots" of data from the sensor, and produces target reports and HRR profiles for a particular instant of time. The task of integrating successive snapshots together is performed by the tracker. A typical kinematic tracker uses models of target motion to determine which objects detected at one instant are physically the same as the objects at the next instant. The feature-aided tracker implemented here adds to this process by using the HRR profile of the target to aid the target-track association process. It matches the HRR profile against the previous values and, if possible, classifies the target and match against the previous classification.

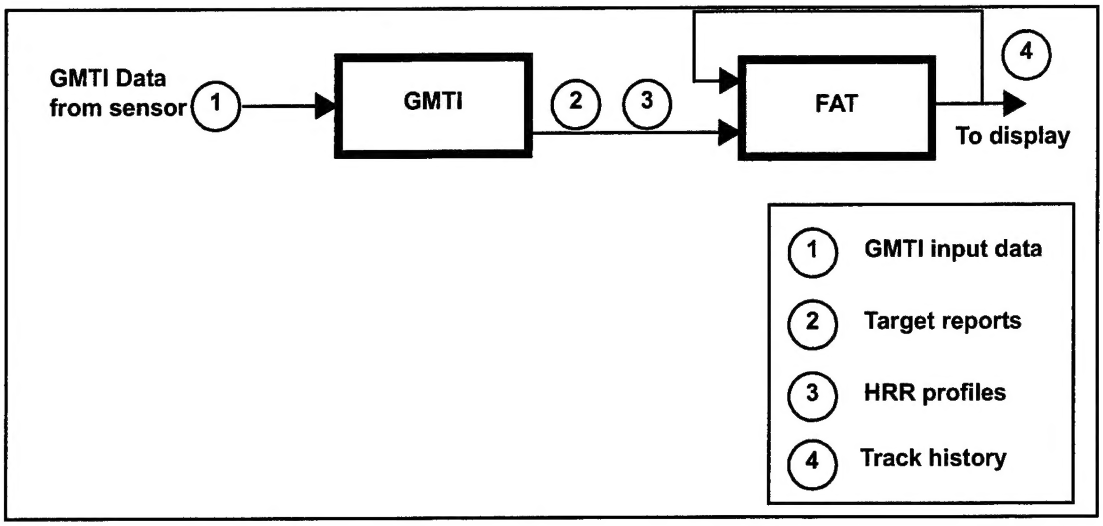

Figure 1. Block diagram of integrated radar-tracker application.

There are many opportunities for parallelism in the implementation of these tasks. In a typical embedded signal processor, one would expect that the GMTI and FAT blocks would run in a task-parallel fashion. In the Matlab implementation, the tasks are treated as a single serial data flow because of the limitations of the language.

ACRONYMS

FAT — Feature-Aided Tracking

GMTI — Ground Moving Target Indicator

HRR — High Range Resolution

MTI — Moving Target Indicator

PCA — Polymorphous Computer Architecture

PDR — Preliminary Design Review

REFERENCES

[1] William G. Coate, "Preliminary Design Review: Kinematic Tracking for the PCA Integrated Radar-Tracking Application," MIT Lincoln Laboratory Project Report PCA-IRT-4, 25 February 2003, issued 6 February 2004.

[2] Duy Nguyen, John Kay, Bradley Orchard, and Robert Whiting, "Classification and Tracking of Moving Ground Vehicles," MIT Lincoln Laboratory Journal, Volume 13, Number 2, 2002.

[3] Albert I. Reuther, "Preliminary Design Review: GMTI Processing for the PCA Integrated Radar-Tracker Application," MIT Lincoln Laboratory Project Report PCA-IRT-2, 8 April 2002, issued 6 February 2004.

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J.M. Lebak

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Lincoln Laboratory, MIT
244 Wood Street
Lexington, MA 02420-9108

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